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SINO-SOVIET AIR DEFENSE CAPABILITIES THROUGH MID-1965

Submitted by the
DIRECTOR OF CENTRAL INTELLIGENCE

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Concurred in by the
UNITED STATES INTELLIGENCE BOARD

on 29 March 1960. Concurring were the Director of Intelligence and Research, Department of State; the Assistant Chief of Staff for Intelligence, Department of the Army; the Assistant Chief of Naval Operations for Intelligence, Department of the Navy; the Assistant Chief of Staff, Intelligence, USAF; the Director for Intelligence, The Joint Staff; the Assistant to the Secretary of Defense, Special Operations; and the Director of the National Security Agency. The Atomic Energy Commission Representative to the USIB, and the Assistant Director, Federal Bureau of Investigation, abstained, the subject being outside of their jurisdiction.

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SINO-SOVIET AIR DEFENSE CAPABILITIES THROUGH MID-1965

THE PROBLEM

To estimate the scale and nature of the Sino-Soviet Bloc air defense system, and probable trends in its capabilities through mid-1965.

SUMMARY AND CONCLUSIONS

Soviet Air Defense Policy

1. The Soviet leaders recognize that an effective air defense system is an essential element of the strong military posture which they wish to maintain, both to contribute to the security of the Bloc and to support their foreign policies. The scale of effort presently being applied to the continuing improvement and modernization of the Soviet air defense system is indicative of the high priority assigned to this mission.

2. The air defenses of the Sino-Soviet Bloc are designed primarily to provide defense in depth for major population, industrial, and military centers, especially those in the USSR. They also provide a barrier around much of the Bloc's periphery. In order to attain maximum effectiveness, all Soviet forces deployed for the air defense of the USSR are under the operational control of a single major command. In addition to forces directly assigned, other Soviet forces which can contribute to the air defense mission are also operationally available to this command. Similarly, the air defense forces of other Bloc nations are closely coordinated with the Soviet system.

Recent Developments

3. The Soviet air defense system is undergoing a major transition which is significantly improving its capabilities against medium and high altitude air attack. The principal aspects of this transition are: (a) the rapid installation of surface-to-air missile sites, and (b) the widespread deployment of an air defense control system with semiautomatic features. Other significant recent developments include the advent of radars with better detection and height-finding capabilities, the introduction of limited numbers of improved interceptors, the estimated introduction of nuclear warheads into surface-to-air missiles, and the probable incorporation of more advanced electronic gear and armament into interceptors.

4. Since early 1958, the USSR has been acquiring rapidly a major operational capability with a second generation surface-to-air missile system (SA–2) designed for defense against aircraft at medium and high altitudes. SA–2 sites, each with six launchers, have been identified at two locations in East Germany, at Moscow, and at many other locations in the USSR, most of them in the western part of the country. Defenses of various densities are apparently programmed for major Soviet cities and other key targets, and possibly for certain border areas. Considering the length of time the program has probably been underway, the relative ease with which sites can be installed, and the observed patterns of deployment, we estimate that some 250–300 SA–2 sites are now in operational status or being emplaced at nearly 50 Soviet urban areas as well as at other targets.

5. The new air defense control system is now widely deployed in the western USSR and will probably become operational throughout the country and in Eastern Europe within the next few years. This system, which provides high-speed communications with a high degree of reliability and semiautomatic control of interceptors, should overcome most of the deficiencies of the earlier manual system. It will have a marked effect in reducing reaction time and vulnerability to saturation, increasing information handling capacity, and improving coordination within the air defense system.

6. Bloc air defense needs are served by large quantities of other equipment, including about 31,000 antiaircraft guns and about 15,000 jet fighters. The USSR itself has about 10,000 of these fighters, of which about 4,850 have air defense as their primary mission. Some Soviet fighters are probably now equipped with air-to-air missiles. Only about 15 percent of the Soviet fighters are all-weather or limited all-weather types, however. About 2,000 radar sites provide a virtually continuous early warning network around the Bloc's periphery and overlapping coverage in many interior areas.

7. Air defense weapons and equipment are most heavily concentrated in that portion of the USSR west of a line drawn from the Kola Peninsula to the Caspian Sea; in East Germany, Poland, and Czechoslovakia; and in the southern portion of the Soviet Far East. Concentrations are found at some specific locations outside these areas, especially in the Urals and in eastern China. The approaches to Moscow, with some 60 surface-to-air missile sites, 1,100 fighters, and 500 antiaircraft guns, are by far the most heavily defended area of the Bloc.

Current Capabilities

8. The present capabilities of the Soviet air defense system would be greatest against penetrations by subsonic bombers in daylight and clear weather at altitudes between about 3,000 and about 45,000 feet. Under such conditions, virtually all types of Bloc air defense weapons could be brought to bear against attacking aircraft. Fighters would retain some effectiveness at altitudes in excess of 50,000 feet, but the capabilities of the fighter force would be reduced considerably during periods of darkness or poor visibility. In the increasingly widespread areas defended by surface-to-air missiles, air defense capabilities would be unimpaired by weather conditions and would extend to at least 60,000 feet in altitude.

9. Despite the improvements in the Soviet air defense system, it still has basic weaknesses in coping with a sophisticated air attack. At altitudes below about 3,000 feet, the capabilities of the system would be progressively reduced; below about 1,000 feet, the system would lose most of its effectiveness. Against varied penetration tactics utilizing altitude stacking, diversionary maneuvers, standoff weapons, decoys, and electronic countermeasures, air defense capabilities would be significantly diminished. In addition, the Soviet defense problem would be complicated by the variety of delivery systems which might be employed, including cruise-type missiles, fighter-bombers, and supersonic bombers.

Future Trends

10. Soviet planners must recognize that the great destructive power of nuclear weapons requires that the defense achieve the closest possible approximation of a complete denial of access to vital targets. They will expect manned bombers to remain a major element of the West's capability for nuclear attack over the next five years, but their air defense problems will be complicated by the increasing numbers of Western ballistic missiles.

11. To meet the manned bomber threat, the Soviet leaders contemplate heavily increased reliance on missiles for air defense. Their comprehensive defense system, combining fighters and surface-to-air missiles, is probably designed to provide maximum opportunity for successive attacks on penetrating delivery vehicles from the Soviet borders to critical target areas in the interior. Judging by recent trends, a basic program for SA–2 defenses, with 350–400 sites deployed at about 70–80 locations including some 60–65 urban-industrial targets in the USSR, could probably be completed by the fall of 1960. A more extensive program of 500–600 sites and field force units could probably be completed some time in 1961.

12. In order to reduce their current vulnerability to low level attack, the Soviets probably have under development a missile system designed to engage targets at very low altitudes. Such a system could become operational in late 1960, although an initial operational capability in 1961 would be more likely. It could probably be widely deployed as a supplement to existing defenses by 1962 or 1963. As the period advances, the USSR will probably strive also to increase its capabilities against advanced bombers and cruise-type missiles.

13. Early warning ranges and reaction times will continue to permit defense forces to be brought to bear against subsonic delivery vehicles. For defense of targets on the periphery of the Bloc against supersonic Western aircraft and cruise-type missiles, however, warning times will be marginal for the effective employment of fighter interceptors. Warning requirements for surface-to-air missiles will probably not be so stringent. As improved communications and control equipment becomes more widespread, the saturation point of the air defense system will be considerably raised.

Future Soviet Air Defense Capabilities

14. We believe that the Soviets will continue to improve the overall capability of their large and complex air defense establishment. Despite these improvements, the Soviets probably will still not achieve within this time period a high degree of

assurance in dealing with a large-scale sophisticated attack by manned bombers armed with high-yield nuclear weapons. They would probably expect to destroy a significant number of the attackers, but, given the increasing complexity of the air defense problem, we doubt they will be confident of the extent to which they could reduce the weight of any given attack.

15. Moreover, in the early part of the period, the Soviets will almost certainly have no defense against ballistic missiles, although a high priority effort to develop such a defense probably is now underway. In the 1963–1966 period the Soviets could achieve a defense system of undetermined capability against ICBMs and other ballistic missiles. But, barring an unforeseen technological breakthrough, we believe that the USSR's air defense problems, deficiencies, and uncertainties will increase toward the end of the period as ballistic missiles assume a larger proportion of the West's total nuclear delivery capability.

Nuclear Weapons

16. The USSR has developed low-yield nuclear warheads suitable for air defense use, and we believe that some of their surface-to-air missiles are probably armed with such warheads. In the absence of further nuclear testing, progress in the very low-yield category, suitable for air-to-air missiles, would be seriously hindered. The lack of nuclear testing would also handicap, but not prevent, development of a nuclear-armed antimissile system.

Other Bloc Nations

17. The air defense forces of the other Bloc nations will remain inferior to those of the USSR. They will be augmented by the transfer of fighters and antiaircraft guns from Soviet stocks, continued local production of such equipment, and the provision of up-to-date radar and communications equipment. The USSR will probably supply surface-to-air missiles in at least limited numbers to other Bloc nations after priority Soviet requirements have been met. There are indications that East German and Chinese Communist fighter forces may now have air-to-air missiles.

Civil Defense

18. Civil defense preparations in the USSR are supervised by a central agency with staff representatives at regional and local levels. Some civil defense instruction and indoctrination has been given to a majority of the urban population, and we believe that some select groups, such as workers in key factories and students, have probably received more intensive training. Subways and basement shelters, which presently could accommodate perhaps 17 million persons, could provide some protection against fallout. Heavy bunkers and tunnel-type shelters have been constructed for approximately two million key personnel. The civil defense programs of the European satellites are patterned after that of the USSR. The programs of Communist China and the Asian Satellites are much less elaborate.

DISCUSSION

GENERAL AIR DEFENSE POLICY

19. The Soviet leaders consider that the security of the USSR rests primarily on the overall relation of forces in the world; moreover, they consider that their political, economic, and military posture in this relationship has grown greatly in recent years, and is destined to still greater strength in the years ahead. As one key element in this overall posture, achievement of improved air defense not only contributes to greater general security, but also provides a basis for freer political maneuver—including support to a stronger Soviet stand in moments of crisis—by reducing the likelihood of enemy resort to arms.

20. In planning and programming their air defense, Soviet planners must assume for reasons of national security that, in any of the likely situations under which war might occur, a substantial attacking force would reach the USSR. It is on this basis, we believe, that the Soviets have been concerned to achieve a high level of air defense.

21. The scale of effort presently being applied to the continuing improvement and modernization of the Soviet air defense system is indicative of the high priority assigned to this mission. The further development of the system to cope more effectively with a manned bomber threat suggests that they expect to be concerned with this threat at least through the period of this estimate. We do not believe that the Soviets' development of a large strategic attack capability with long range missiles will lead them to conclude that they do not require an extensive air defense system. Consequently, we believe that they will continue to give a high priority to its further buildup and improvement. As the period advances the system will be required to take on the wholly new role of antimissile defense in addition to defense against aerodynamic vehicles.

22. The air defense mission will probably require increased expenditures. However, owing to the rapid growth in Soviet economic resources and to the high priority which the air defense mission will continue to enjoy, we believe that economic considerations will not hinder the substantial programs estimated for Soviet air defense.

ORGANIZATION OF AIR DEFENSE

23. In order to attain maximum effectiveness of air defense capabilities, all Soviet forces deployed for air defense of the USSR are under the operational control of a single major command. Some of these forces are assigned directly to this command. Other Soviet forces capable of contributing to the air defense mission are also operationally available to this command for augmentation of its own forces. Bloc air defense forces are closely coordinated with the Soviet air defense system in order to provide greater defense in depth for key Soviet administrative, industrial, and military centers.

24. The organization primarily responsible for active air defense of the USSR is the Air Defense of the Country (*PVO Strany*), which combines ground, air, and naval elements under a headquarters which is administratively equal to those of the ground, air, and naval forces. The Commander-in-Chief of the *PVO Strany* is *ex officio* a Deputy Minister of Defense and the chief adviser to the Minister and Chief of the General Staff on air defense matters. The Headquarters of the *PVO Strany* in Moscow prepares overall plans and coordinates training and operations in air defense.

25. The chief components assigned to the *PVO Strany* are the Air Observation, Reporting, and Communication (VNOS) service, the Fighter Aviation of Air Defense (IA–PVO), and the Antiaircraft Artillery of Air Defense (ZA–PVO), the latter component including both antiaircraft guns and surface-to-air missiles.

26. For control purposes, the USSR is divided into a number of air defense districts with central control at Moscow.[1] There are at least two major regional centers, one at Moscow and the other at Khabarovsk for the Far East. At present it is estimated that the whole of the Sino-Soviet Bloc air defense system is divided into about 40 air defense districts, of which 21 are in the USSR. As the speeds and other capabilities of offensive and defensive systems increase, the Soviets may find it expedient to reduce the number of air defense districts and to divide them into fewer and larger sectors.

27. The air defense district headquarters is responsible for the coordination and operational control of all forces in the district able to contribute to air defense. It is also responsible for identification and filtering of tracks and passing air situation data to Moscow or Khabarovsk, to adjacent air defense districts, to subordinate sectors, and to other agencies within the district. The air defense district is divided into a number of sectors according to the size and importance of the district and the density of air defense forces deployed within it. In most cases, the air defense sector control center is colocated with fighter division headquarters. The air defense sector, the basic operational air defense unit, performs duties similar to those of the air defense district, but within its more limited area.

28. The major field commands—Military Districts, Fleets, and Soviet Groups of Forces in the Satellites—have their own air defense elements intended primarily for protection of the military forces and installations. The deputy commanders for air defense in these commands coordinate air defense activities with the appropriate *PVO Strany* headquarters and districts. Among their subordinate elements with a stationary and exclusively air defense role are certain AAA brigades and regiments deployed at key fixed targets, separate fixed AAA battalions employed for protection of military airfields, and Fleet AAA units defending naval bases. Fighters of Tactical and Naval Aviation augment the interceptors in the IA–PVO, in addition to their role of support to the ground and naval forces. Finally, all other AAA units assigned to ground forces field formations in the USSR probably also have channels of coordination with the *PVO Strany*.

29. The Eastern European Satellites, Communist China, and North Korea have national air defense systems modeled after that of the USSR and coordinated with it in an overall Bloc system. This Bloc system probably does not include unified command or integration of forces, but there are established channels for communication of operational air defense information.

WEAPONS AND EQUIPMENT[2]

Surface-to-Air Missiles

30. The major development in Soviet air defense over the past few years has been the extensive deployment of surface-to-air missiles for defense of key target areas. The Soviets now have operational two types of surface-to-air missile systems. The first of these (SA–1) has been operational for several years and is deployed around Moscow in a dense complex

[1] The Assistant Chief of Staff for Intelligence, Department of the Army, believes that the Soviet air defense control system operates as indicated in paragraphs 26–27, but that the organizational structure implied does not take due account of the role played by Soviet major field commands. He believes that there is no parallel and duplicative air defense command system superimposed on other commands. Instead, the integral air defense structures of most major Soviet field commands, utilizing special channels of communication, carry out all air defense responsibilities ascribed in this paper to "air defense districts." In his view there are but few organizational exceptions to the general case, such as the confirmed air defense districts at Moscow and Baku. Other than such special cases, what are termed "air defense districts" in this paper are considered generally coextensive in area and authority with military districts in the USSR, groups of forces as in East Germany, and national military establishments of the Satellites.

[2] For detailed characteristics of Soviet air defense missiles see NIE 11–5–59, "Soviet Capabilities in Guided Missiles and Space Vehicles," dated 3 November 1959, (TOP SECRET) and the forthcoming NIE 11–5–60.

of 56 sites arranged in two concentric rings. There are 22 sites on the inner ring at about 25 n.m. radius from the center of Moscow and 34 sites on the outer ring at about 45 n.m. radius. A typical site has 60 launch positions joined by a road network. The B-200 guidance system at each site employs a track-while-scan radar (designated "Yo-Yo" by US intelligence) having about 54° coverage in both the vertical and horizontal planes. The system also incorporates fire control equipment which enables each site to engage as many as 20 targets simultaneously. This capability, with the spacing of adjacent sites for mutual support and the inner ring of sites for backup, enables the system to direct an extremely high rate of fire against incoming targets.

31. The V–301 missile, as originally designed for use with this system, is unboosted and employs a single liquid sustainer motor. Although its maximum speed is on the order of Mach 2.5, it has a low initial velocity which limits somewhat its engagement capability against supersonic targets. Its maximum intercept range will vary depending upon the approach and type of target; for example, against a directly incoming, high-flying B–52 its range would be on the order of 20 n.m. This missile can carry an HE or nuclear payload of 450–700 pounds and its CEP is estimated to be 65–120 feet. It is believed to be capable of interceptions from a minimum altitude of 3,000 feet up to 60,000 feet, with some additional capability up to about 80,000 feet, particularly if equipped with a nuclear warhead. Because of its cost, immobility, and inflexibility, we do not believe that the SA–1 system will be deployed elsewhere in the Soviet Union. The missile employed in it is probably being replaced by the more advanced GUIDELINE missile described below (paragraph 36).

32. Evidence acquired since mid-1959 indicates the rapid and extensive deployment of a new, mobile, more flexible surface-to-air missile system (SA–2), and there are indications that it could have been operational as early as 1957. The new system appears suitable for the defense of both fixed targets and field forces. A typical site consists of six revetted launching positions deployed around a guidance system and linked by service roads to facilitate loading.

33. SA–2 sites have been identified in operational status or under construction at Glau and Juterbog in East Germany, at Moscow, and at many other locations in the USSR, mostly in the western part of the country, including Baku, Kharkov, Odessa, Lvov, Kiev, Rostov and Sverdlovsk. Deployment patterns and levels of concentration appear to vary according to the geography, size, and shape of the target area, and the Soviet estimate of the worth of individual targets. The sites in the Moscow area, located within the inner ring of SA–1 sites, are probably intended to supplement the existing defenses.

34. Most SA–2 sites appear to defend major centers of population and industry. SA–2 defenses are also believed to exist for the special protection of nuclear materials production and storage facilities. In addition, there are indications that some key Soviet field forces and long range bomber bases are included in the SA–2 deployment pattern. Finally, evidence regarding the deployment of Soviet radars suggests that SA–2 sites may be emplaced in Soviet border areas.

35. In retrospect, we believe that SA–2 deployment has been underway on a wide scale since early 1958, and that the USSR is rapidly acquiring a major operational capability with this system. In estimating the current status of the program, we have considered the length of time it has been underway, the relative ease with which sites can be emplaced and units activated, and the observed patterns of deployment. The construction of sites and the training and activation of firing units has been seasonal, with activity at a minimum during the winter months. Considering the various factors involved, we estimate that at present nearly 50 Soviet urban areas have SA–2 sites deployed in their defense, and that, in addition to the 56 SA–1 sites around Moscow, some 250–300 individual SA–2 sites may already be operational or being emplaced.

36. The missile employed in the SA–2 system is a large, two-stage missile (nicknamed GUIDELINE) which has a solid propellant booster and, probably, a liquid sustainer motor. GUIDELINE's present performance characteristics are better in some respects than those of the SA–1. Maximum intercept range will vary depending upon the approach and type of target; for example, against a directly incoming, high-flying B–52 its range would be on the order of 25 n.m. Maximum velocity is probably about Mach 3. Warhead weight is estimated at about 450–700 pounds and the CEP at maximum range is probably about 100 feet. Maximum effective altitude is about 60,000 feet, with some capability up to about 80,000 feet, especially if employed with a nuclear warhead. Use of the boosted GUIDELINE missile in the SA–1 system will improve that system's capabilities against high altitude and high speed targets and against targets with small radar cross-sections.

37. The SA–2 guidance system includes a fire control radar (nicknamed FRUIT SET) and a surveillance radar (nicknamed SPOON REST). The system is probably similar to the SA–1 guidance system in the employment of track-while-scan radar and radio link for transmission of missile commands. Each site appears capable of 360 degrees coverage. The system possibly can handle two targets at a time, with more than one missile in the air against each target. However, these targets must be within the approximate 12° radar look angle of the FRUIT SET radar.

38. The low altitude capability of the SA–2 system depends upon siting, distance from target, and the receipt of warning in time to alert the system and to train the fire control radar. Under ideal conditions, it could be as low as about 1,000 feet against heavy and medium bombers. Under usual conditions, the SA–2 low altitude capability would be considerably higher, and under unfavorable conditions it might be as high as 7,000 feet. The SA–2 system does not appear to be specifically designed to cope with low-level attacks, but rather for defense against small numbers of penetrators at medium and high altitudes. The principal advantages of this system over the Moscow system lie in its lower unit cost, transportability, and flexibility, although this flexibility is obtained at the expense of target handling capacity.

39. The Soviets are probably equipping some proportion of their surface-to-air missiles with nuclear warheads, in order to increase their capabilities against Western delivery vehicles and especially to increase the chances of a direct "kill" of enemy nuclear weapons. We believe that the USSR has developed low-yield fission warheads suitable for use in surface-to-air missile systems. Three of the Soviet nuclear tests conducted in 1958 were probably connected with this development. They included devices with a variety of yields and economical enough for air defense use. We have no evidence that nuclear warheads are available at existing surface-to-air missile sites, but this does not preclude the existence of at least a limited capability.

Fighter Aircraft

40. There has been little change in the equipment of Bloc fighter forces over the past two years. The Soviet fighter force still consists primarily of day fighters: the obsolescent FAGOT, five versions of the subsonic FRESCO, and three versions of the transonic FARMER. Introduction of the FLASHLIGHT all-weather interceptor and of modified day fighters with limited all-weather capabilities—FRESCO "D" and "E" and FARMER "B"—has proceeded at a relatively slow pace. Approximately 85 percent of the force still consists of gun-armed interceptors equipped with optical fire control systems, which are restricted to pursuit attacks under conditions of good visibility. Soviet all-weather fighters are likewise limited to pursuit attacks. There is good evidence that two new supersonic fighters are now being introduced into Soviet units.

41. Soviet jet fighters appear to have been designed primarily for the interceptor role and therefore have good climb and altitude capabilities. The older Bloc jet fighters, FAGOT and FRESCO, have combat ceilings on the order of 50,000 feet. Combat ceilings of the newer types, including FARMER and FITTER, are on the order of 60,000 feet. At maximum

power, the FARMER is believed to be capable of climbing to 40,000 feet in 2.6 minutes, and the FITTER in 2.2 minutes. The speed, altitude and climb capabilities of the heavier FLASHLIGHT are believed to be somewhat lower than those of the currently operational day fighters.[3]

42. Soviet production of jet fighter aircraft has dropped sharply over the past three years. From 1950 through 1956, annual production ranged from about 3,500 to about 5,000. It is estimated to have declined to about 400–450 in 1959. Production difficulties with the newer models probably have played some part in this decline, but other factors include the high cost and complexity of modern fighter aircraft, the growing destructive power of individual interceptors, and especially the increasing availability and effectiveness of surface-to-air missile systems.

43. *Airborne Intercept Radar.* The FLASHLIGHT's airborne intercept radar, which has an estimated search range of about 12–16 n.m. and a track range of about 6–10 n.m., is believed to be the most effective Soviet AI radar now in use. The FRESCO "D" and "E" have a search capability of about 5–6 n.m. and a track capability of about 2–3 n.m. The FARMER "B" radar has a search range of about 7–9 n.m. and a track range of about 3–5 n.m. These estimated ranges are calculated for B–47 size targets.

44. The gun armament of Soviet fighters has not kept pace with improvements in aircraft performance characteristics. Most Soviet fighters are still equipped with pre-1958 large caliber guns having relatively low muzzle velocity and rate of fire. Only the FARMER "B" and "C" and the FITTER are believed to have revolver type guns. Older models are equipped with gun sights with manual range input, but more recent models employ sights with radar ranging. If the newer Soviet fighters such as FARMER and FITTER are to achieve a satisfactory intercept and kill capability, they will require air-to-air missile armament. Most Soviet interceptors are believed capable of employing unguided rockets, guided missiles, or combination armaments.

45. *Air-to-Air Missiles.* We have only scanty evidence regarding Soviet air-to-air missiles. However, based largely on considerations of Soviet requirements and capabilities and what slight evidence is available, we estimate that the USSR now has three short range (up to six n.m.) air-to-air missile systems available for employment with day and all-weather interceptors, including a beam rider missile, an infrared homing missile, and an all-weather semiactive radar homing missile. These missiles are believed to employ HE warheads. There are some indications that one or more of the foregoing types of missiles are now operational with Soviet interceptors, and it is possible that they have been supplied to the East German and Chinese Communist Air Forces.

Early Warning and Ground Controlled Intercept Radar[4]

46. The Soviet early warning (EW) and ground controlled intercept (GCI) system employs a very large number of radars deployed to provide a very high duplication of coverage in many areas. Properly exploited, the resultant high signal density would increase the USSR's capability, in a jamming environment, to maintain track of attacking Western aircraft.

47. *Early Warning Radars.* Many types of radar are utilized for long range early warning in the Soviet Bloc. The most widely used are the TOKEN and KNIFE REST. However, seven new S-band radars have been developed from the basic TOKEN and are being widely deployed. Several of these sets have frequency diversity. The most effective of these is BAR LOCK, which probably is intended to be the prime EW radar in Bloc air defenses after 1960. Under average conditions, primary early warning radars now in use can probably detect jet medium bombers penetrating at altitudes up to their combat ceilings at distances of 100 to 220 n.m. from radar sites. Maximum altitude

[3] For detailed estimates of the performance characteristics of Soviet fighter aircraft, see Table 1, Annex A.

[4] For detailed characteristics of Soviet EW and GCI radars see, Table 2, Annex A.

capability for the TOKEN, used in an EW role, is about 75,000 feet, and for other EW radars, from 100,000 to well over 200,000 feet.

48. *GCI Radars.* Because of its moderately accurate height-finding capability, TOKEN is also widely used in a GCI role. Much more accurate height-finding radars are employed at GCI sites in combination with the newer S-band radars. Theoretically, maximum altitude coverage of Soviet GCI radars could extend up to about 70,000 feet with the TOKEN, and up to an estimated 220,000 feet with the BAR LOCK/STONE CAKE or CROSS OUT/STONE CAKE combinations. Under operational conditions these theoretical maximums would not be attained. However, the height coverage capabilities of Soviet radars will probably not be the limiting factor in Soviet GCI capabilities during the period of this estimate.

49. In general, the low altitude effectiveness of Soviet early warning and GCI radars is limited, although some operational radars are now believed to have moving target indicators. The development of high frequency ionospheric back-scatter radars which could be used for detection of ICBM launchings has been within Soviet capabilities for at least five years, and some such radars may now be in position.

Antiaircraft Guns

50. The Soviets continue to employ large numbers of antiaircraft guns for defense of field forces and fixed targets including airfields. The standard light, medium, and heavy AA guns are the 57 mm., the 100 mm., and the 130 mm. The obsolete 37 mm. and 85 mm. guns are rapidly being replaced in Soviet units, but are still found in considerable numbers in other Bloc AA units. Soviet field forces also have large numbers of automatic antiaircraft machine guns. For mobile defenses and low altitude coverage, the 57 mm. gun offers a serious threat to low-level aircraft and to aircraft up to 15,000 feet. Under certain conditions, the 130 mm. gun can deliver continuous pointed fire well above 40,000 feet. However, the 100 mm. gun, the principal type now employed in static defenses, declines rapidly in effectiveness against targets at altitudes above 35,000 feet or at speeds in excess of 400 knots. A large percentage of these guns employ fire control radars. The use of proximity fuses, which are believed to be available, would further increase their capability.

51. *AAA Fire Control Radar.* The WHIFF and FIRECAN, both Soviet versions of the US SCR-584, remain the primary antiaircraft fire control radars. They both operate in the S-band and have ranges considerably in excess of the guns with which they are employed. A new, higher-performance set, FIRE WHEEL, is now appearing in increasing numbers. CROSS FORK, which was widely used as an acquisition radar, has now been replaced on most sites by KNIFE REST, and, in some cases, by a new radar, FLAT FACE. SPOON REST, used with the SA-2 missile system, may also be used with AA gun units as acquisition radar.

Other Electronic Equipment

52. *Communications and Control.* Soviet ground communications have been improved over the last few years by the large-scale introduction of landlines and microwave equipment. It is believed that landlines and possibly microwave are the primary means of point-to-point air defense communications, with high frequency radio still widely used. In the far north and other remote areas, low frequency (LF) and high frequency (HF)—vulnerable to countermeasures and adverse atmospheric conditions—remain the major means of passing air defense data. [redacted] There is as yet no indication of the employment of ultrahigh frequency (UHF) systems for air-to-air and air-to-ground communications.

53. The most important advance in Soviet air defense communications over the last few years has been the development and deploy-

ment of a new air defense control system with some semiautomatic features, including data-handling equipment for rapid processing of air defense information and data-link equipment for vectoring interceptors. This system, which is similar in concept to the US SAGE system, but less complex, is now believed to be widely deployed in the western USSR and will probably become operational throughout the USSR and Eastern Europe within the next few years. It is expected that data-handling equipment will increase the traffic capacity of each Soviet radar reporting site to at least 20 simultaneous tracks, and that, when the system is fully implemented, this could be increased to 30–40 tracks. Fighter control centers in the system probably are designed to handle 50 intercepts simultaneously, but we believe the present capability is less than 10. By the end of the period of this estimate, the full design capability of the system may be realized. This system, which provides high-speed communications with a high degree of reliability and accurate semiautomatic control of interceptors, should overcome most of the deficiencies of the present manual system. It will have a marked effect in reducing reaction time and vulnerability to saturation, increasing information handling capacity, and improving coordination within the Soviet air defense system.

54. *Electronic Countermeasures.* At present, the USSR has a capability for jamming Western bombing and navigational radars at frequencies up to 10,000 megacycles and possibly higher, and especially for jamming the lower frequencies normally used in Western long range radio communications. Shipboard and ground jamming equipment for use against X-band blind bombing radar is known to exist. In addition, some FRESCO "D" interceptors with large belly protrusions are believed to carry an X-band spot noise jammer, but this equipment does not seem to be widely used. The Soviets are known to have employed electronic deception, including simulation of Western navigational aids, against Western aircraft. They are now producing magnetrons and travelling wave tubes suitable for jamming in the microwave frequencies, and research in this field is continuing. They are also currently employing passive detection equipment believed capable of detecting signals from the very low frequencies up into the microwave spectrum. Toward the end of the period of this estimate, the USSR will probably have in operational use equipment capable of jamming at frequencies from 10 kc/s through 36,000 mc/s, including all frequencies likely to be employed by Western communications, radar, and navigation equipment.

55. *Electronic Counter-Countermeasures* (ECCM). The USSR is aware of the effectiveness of countermeasures against radar and has for a number of years conducted both electrical and mechanical jamming exercises designed to make its air defenses proficient in the face of enemy countermeasures. In the last few years, a trend toward greater frequency diversification has appeared in Soviet radar and radio equipment. Increased power and other antijamming techniques also appear to be receiving attention and are probably incorporated in the latest Soviet radars.

56. *Navigational Aids.* Within the last few years, the USSR has extensively improved its interceptor aircraft recovery system by augmenting the elementary two-beacon approach system with installation of distance-measuring equipment, air surveillance radar, instrument landing systems, and GCA equipment. Although differing in some details, this equipment is comparable to that used by NATO nations.

57. *IFF Equipment.* For the past few years, the Soviets have been converting to an improved IFF system to replace a system which was relatively insecure and easily countered. We estimate that the new system probably will have completely replaced the older system by 1961.

STRENGTH AND DEPLOYMENT

58. The large quantities of air defense weapons available to the Bloc are deployed primarily in defense of key Soviet static targets and military forces. Total Bloc jet fighter strength, as of 1 January 1960, is estimated

at about 15,000, of which about 10,000 are in Soviet fighter units. Of these, about 4,850 are in Fighter Aviation of Air Defense (IA-PVO), with air defense as their exclusive mission. Operational Bloc AA guns are estimated to total about 31,000, including about 18,000 light guns, about 12,500 medium guns, and 500 heavy guns. More than 70 percent of this total are in Soviet units. Regarding deployment of surface-to-air missiles, we believe that the USSR may now have operational or being emplaced some 250–300 SA–2 sites, mostly around main industrial centers, in addition to the 56 SA–1 sites in the complex around Moscow. There is no evidence that any surface-to-air missiles have been given to any other Bloc nation, and this is not expected to occur until Soviet needs are more fully satisfied.

59. Generally, the most advanced weapons are deployed first within the USSR, and in a manner to make maximum use of their capabilities. New supersonic interceptors, now entering service, have appeared first in units near peripheral urban areas, apparently to provide cover to routes of approach to interior targets. This deployment is consistent with its best capability as an area defense weapon. The bulk of Soviet all-weather fighters are based in peripheral areas of the USSR and to a slightly lesser degree around the larger urban centers. Soviet surface-to-air missiles deployed to date are apparently intended primarily for point defense, although the sites seem to be deployed variously, in accordance with the particular features of each area, in order to make a maximum contribution to area defense as well. Antiaircraft guns are usually located closer to the defended area than fighters or missiles, and are deployed in depth, with heavy and medium guns farthest out from the center, and the light AA guns closer in.

60. The areas of greatest concentration of Bloc air defense weapons and associated equipment include that portion of European USSR from the Kola Peninsula to the Caspian, East Germany, Poland, Czechoslovakia, and the Maritime and Sakhalin areas of the Soviet Far East. Heavy defense concentrations are also found at some specific locations outside these areas, especially in the Urals and in eastern China. The approaches to Moscow are by far the most heavily defended area of the Bloc. Moscow's defenses include about 60 surface-to-air missile sites, nearly 1,100 day and all-weather fighters, and about 500 antiaircraft guns. Although we have no direct evidence, some portion of the surface-to-air missiles probably are armed with nuclear warheads. Moscow's defenses are estimated to have a high capability to engage large-scale attacks under all-weather conditions, but probably remain vulnerable to very low altitude attack.

61. About 1,200–1,500 heavy prime radars, primarily of the TOKEN and BAR LOCK types, and about 3,000 light auxiliary radars are deployed in about 2,000 radar sites in the Sino-Soviet Bloc.[5] These sites are so disposed as to produce virtually continuous overlapping coverage of the periphery. Simultaneous coverage of a penetrating target by three or more radars can probably be achieved through most of European USSR, the Satellites, and the Pacific coastal areas. Gaps in peripheral early warning radar coverage now appear only in southwestern China. Radar equipped ships are available to supplement and extend radar cover in maritime border areas of the USSR.

62. The extent of this radar cover is impressive, but its quality varies with the area to be defended. In well defended areas, the most solid warning cover exists from about 50,000 feet down to 3,000 feet. Height-finding capacity, particularly for altitudes above 40,000 feet, depends upon the availability of the newer height-finding equipment, which is not yet deployed in sufficient numbers to provide dense coverage in all areas. Wider deployment of the new types of radars already in service, together with developments in automated control systems, probably will lead to a decrease in total radar numbers within the next five years.

[5] See Table 2, Annex A, for estimated operational characteristics of these various radars.

OTHER FACTORS AFFECTING AIR DEFENSE CAPABILITIES

Air Facilities

63. More than 350 airfields in the Sino-Soviet Bloc are currently being used for air defense operations. There are, in addition, many other airfields which could be used to support air defense operations and which are geographically located in areas considered significant for air defense.

64. In the USSR, most of the airfields suitable for jet fighters were developed prior to 1958. Since that date, construction or improvement has continued on a more limited scale and has occurred chiefly in the Arctic and other remote areas. Despite the considerable activity in the Arctic since 1952, facilities are still inadequate for deployment of fighters in the central Arctic, except for a few widely separated bases.

65. Airfield construction in the Satellites was at a high level during the period 1950–1956 and has since tapered off. However, a moderately active program of improvement and construction has been underway in this area during the last two years. Many of the former 6,600 and 7,200 foot runways at military airfields are being lengthened to 8,200 feet, probably because of the longer runway requirements of later model and higher performance aircraft. At both Soviet and Satellite airfields, navigational aids and night lighting equipment appear adequate to support present requirements.

66. In Communist China, at least seven major airfields have been constructed in the coastal and interior regions during the last two years. In addition, the runways of about eight existing airfields have been extended and landing aids have been modernized. At least 10 Chinese Communist airfields are believed to be equipped with GCA.

Logistic Support and Maintenance

67. We estimate that the Soviet supply system, transportation network, and local storage facilities are adequate to meet immediate air defense needs in most areas. Antiaircraft gun and missile installations, airfields, and radar stations are usually located adjacent to populated areas and/or main transportation and communication lines. Maintenance procedures appear to be exacting and carefully supervised, and maintenance of equipment is considered to be good to excellent. Evidence on Soviet electronic equipment indicates that it is generally reliable and well maintained.

68. *Jet Fuel.* Although information is lacking on the exact location of jet fuel storage points in many areas and the amount of fuel actually stored, operational Bloc fighter bases are believed generally to have sufficient stocks of jet fuel for 15–20 days sustained combat operations. POL storage facilities on many Bloc airfields have been expanded and probably now have adequate capacity for training, normal flight operations, and the required reserves for emergency use. There are no indications that training activity has been widely curtailed because of the lack of jet fuel, although in some instances training appears to have been reduced because of short supplies of jet fuel locally, probably due to transport difficulties.

69. *Jet Serviceability.* We estimate that, for present jet fighters, an immediate serviceability rate on the order of 80 percent of unit strength could be achieved without special preparations. Following a 5–10 day standdown, this rate could be temporarily increased to about 90 percent for about one week, and then could be maintained at about 80 percent for about another week. Thereafter, serviceability rates could be maintained at about 70 percent for approximately six months under combat conditions, and would then decline to 40–60 percent. Under extreme weather conditions and in areas not served by adequate transportation, such as in the Arctic, the above serviceability rates would be reduced.

Personnel and Training

70. We believe that technical skills and training of air defense personnel are generally adequate, although we have insufficient evidence to permit an assessment of the training of certain categories of personnel, notably those in

the air warning services. Training standards in the Satellites and Asian Communist nations are lower than those in the USSR. Throughout the Bloc, however, personnel requirements are probably fulfilled on a priority basis in accordance with the emphasis placed on air defense.

71. The USSR has maintained 24 fighter pilot training schools with an estimated annual output of about 2,400 graduates. These numbers will presumably decline over the next several years with the reduction in the size of the fighter force. The course of instruction lasts slightly less than three years, during which time each pilot accumulates about 115 pilot hours—35 hours piston-engine and 80 hours jet. Very little time is devoted to night and instrument training during the preoperational phase.

72. Once a Soviet fighter pilot has been assigned to an operational unit, he probably averages only about 10 hours flying time per month.[6] In 1950, training goals were to acquire fully the technique of interception and destruction of large hostile air formations, but these goals probably now include interception and destruction of single aircraft and small formations. Instrument training is conducted in operational units. Night flying has increased considerably and the standards have probably been raised, but we believe they are probably below US standards.

CIVIL DEFENSE

The Soviet Program

73. Civil defense in the USSR is supervised by the headquarters of Local Antiair Defense of the Country (*MPVO Strany*). Subordinate to the headquarters in Moscow are MPVO staffs at republic, oblast, city, and rayon levels. These staffs are responsible for planning, materials supervision, and training, and their members are schooled at an MPVO institute located in Leningrad.

74. At the local level, the MPVO staffs rely primarily on already-existing governmental agencies—police, fire departments, medical installations, plant guards, etc.—for civil defense functions. These agencies, supplemented by auxiliary personnel to bring them up to strength, are organized as civil defense units for such functions as fire defense, shelter and cover, blackout, and decontamination. Advised by the MPVO staff, line officials of the government hierarchy, such as the oblast MVD chief or the chairman of the city executive committee, function as the responsible civil defense commanders.

75. Training the Soviet population in civil defense is the responsibility of a paramilitary organization known as DOSAAF (Voluntary Society for Cooperation with the Army, Aviation, and Fleet). About one-fifth of the Soviet adult population is formally enrolled in this organization. The DOSAAF training program in some areas has been plagued by an indifferent teaching staff, and apparently by padding of progress reports. DOSAAF aims at training the entire civilian population, with virtually all Soviet citizens between the ages of 16 and 60 liable for compulsory service with civil defense. The majority of the urban population has been given at least a portion of the scheduled training, but the general public's participation in alerts and drills has been limited to clearing the streets and complying with blackout regulations. Some select groups, such as workers in key factories and students, probably have received more intensive training.

76. Basement shelters may be available for as many as 15 million people, while another 2 million could find refuge in the subways of Moscow and Leningrad. Partially completed subways now exist in Kiev, Tbilisi, and Baku. Basement shelters could provide some protection against fallout, but they are of little use against heavy blast. If provided with special doors, subway shelters could provide better protection against fallout as well as against blast and thermal effects. However, there is little evidence to indicate that stocks of food and water have been provided for subway or basement shelters. Heavy bunkers and tunnel-type shelters have been constructed for approximately two million selected persons

[6] US fighter pilots average 20 hours per month.

employed at communications installations, government headquarters, civil defense and military command posts, and major industrial plants. Virtually nothing has been done to provide shelter for the rural population.

77. It is probable that the USSR has prepared for the evacuation of key party and government personnel from Moscow in the event of an emergency. City civil defense services, such as those for fire fighting, medical aid, and reconnaissance, are to be evacuated and given shelter on the periphery of urban areas. Recently, some consideration has been given to evacuating nonessential elements of the civil population upon official declaration of a "threatening situation." A transportation service, specifically charged with the evacuation of school children and disabled persons was added to the operating units of the city MPVO system in 1958. Special units of the MPVO, with disaster relief functions, also appear to have come into existence.

78. Although the Soviet civil defense program represents an effort of longstanding and there are indications of increased emphasis on certain aspects of civil defense, a number of gaps remain. The most important deficiency is the lack of adequate shelter for the bulk of of the population. This deficiency will persist during the period of this estimate, although the amount of basement shelter will be increased considerably, and possibly doubled, as the result of new apartment and other construction. Civil defense training has been hampered by public apathy and poor instruction, but the civil defense program by its continuity alone, is imparting rudimentary indoctrination to an ever-widening circle and has probably created a corps of relatively well-trained staff specialists. The superimposition of civil defense programs on already existing factory, police, and local government units is probably sound and realistic. Against the background of the general regimentation of life in the USSR, these factors would tend to reduce casualties and facilitate the reinstitution of administrative control in areas which have suffered peripheral damage.

Civil Defense in the European Satellites

79. In the European Satellites, civil defense programs resemble that of the Soviet Union. Central agencies, usually attached to the ministry of the interior, exist to administer the programs. Some East German and Czechoslovak civil defense officials have been trained at the MPVO school in Leningrad. Instruction of the population is, as a rule, carried on by a paramilitary organization similar to the Soviet DOSAAF. Public training is most actively carried on in Poland, East Germany, and Czechoslovakia. Basement shelters in new apartment house construction appear to be standard in the four northern Satellites. All the Satellite regimes are believed to have constructed bunker-type shelters for key personnel. There have been scattered references to the evacuation of some elements from cities. Public apathy toward civil defense is widespread in the Satellites. Only in Poland has the regime made any serious effort to acquaint the public with the latest developments in civil defense through radio broadcasts and the public press.

Civil Defense in Communist China and the Asian Satellites

80. Communist China, North Korea, and North Vietnam possess rudimentary civil defense organizations; their programs for training the public are limited and sporadic. The Chinese leaders may fear that a major civil defense effort would involve unacceptable expenditure and might impair the national confidence. Moreover, these leaders appear to believe that their country's vast size and population makes it less vulnerable to nuclear devastation. However, some shelters are available in Communist China and North Korea for key government personnel.

CAPABILITIES OF THE PRESENT SOVIET AIR DEFENSE SYSTEM

81. On the basis of the foregoing discussion, we conclude that the Soviet air defense system is undergoing a major transition which is significantly improving its capabilities against medium and high altitude air attack. The principal aspects of this transition are:

(a) in weapon systems, the rapid installation of surface-to-air missile defenses, and (b) in communications and control, the widespread deployment of an air defense control system with semiautomatic features. Other significant developments include the advent of radars with better detection and height-finding capabilities, the introduction of limited numbers of improved interceptors, the estimated introduction of nuclear warheads into surface-to-air missiles, and the probable incorporation of more advanced electronic gear and armament into interceptors.

Against Subsonic Bombers

82. The present capabilities of the Soviet air defense system against subsonic bombers would be greatest when penetrations were conducted in daylight and clear weather at altitudes between about 3,000 and about 45,000 feet. Under such conditions, virtually all types of Bloc air defense weapons could be brought to bear against attacking aircraft. Antiaircraft gun and fighter intercept capabilities would diminish above 45,000 feet, although present Soviet fighters could operate with some effectiveness at altitudes in excess of 50,000 feet. At altitudes below about 3,000 feet, the capabilities of the system would be progressively reduced; below about 1,000 feet, the system would lose most of its effectiveness.

83. Because of the limited availability of all-weather fighters, the capabilities of the fighter force would be reduced considerably during periods of darkness or poor visibility. However, in the increasingly widespread areas defended by surface-to-air missiles, air defense capabilities would be unimpaired by visibility or weather conditions and would extend to at least 60,000 feet in altitude. Radar-controlled antiaircraft guns could also engage in continuously pointed fire under any visibility or weather conditions, within their altitude limitations.

84. The principal current weaknesses in the Soviet air defense system are: its limited all-weather fighter capability; the traffic-handling capabilities of communications and control components; the inadequate low altitude tracking capability; deficiencies in fighter armament; the limited early warning time available in Bloc border areas; and the lack of an operational surface-to-air missile specifically designed for use against very low altitude attacks.

85. Against varied penetration tactics utilizing altitude stacking, diversionary maneuvers, standoff weapons, decoys, and electronic countermeasures, the capabilities of the air defense system would be significantly diminished. In particular, a manned bomber attack below 1,000 feet altitude would seriously degrade the EW/GCI system's capability of maintaining continuous track and vectoring interceptors under close control. Such an attack would also render the medium AAA ineffective and be relatively invulnerable to both the SA–1 and SA–2 surface-to-air missile systems.

Against Other Delivery Systems

86. Soviet defense capabilities against current Western fighter bombers, supersonic bombers, and cruise-type missiles are more difficult to assess, but probably are generally inferior to their capabilities against subsonic bombers. The smaller radar cross-sections of these delivery vehicles would reduce the Soviet ability to detect them and to give warning to defensive weapons. Assuming successful detection and tracking, interception by fighters could probably be accomplished only by the limited numbers of transonic and supersonic types now in Soviet units. Surface-to-air missile systems, however, would have a considerably greater capability against such vehicles, except at low altitudes.

87. We believe that the Soviets do not now have an active defense capability against ballistic missiles of any type.

PROBABLE FUTURE TRENDS

88. In estimating the future development of Bloc air defenses, we have taken a number of considerations into account, including: (a) our general estimates of Soviet strategic thinking and air defense policy; (b) the observed trends in the air defense system over the past few years; (c) present air defense weaknesses which Soviet planners presumably wish to

overcome; (d) the likely Soviet estimate of future trends in Western delivery systems; (e) known and estimated Soviet scientific and technical programs and capabilities to develop more advanced air defense weapons and equipment; and (f) the economic resources available and the considerations we believe the Soviets would take into account in allocating resources to air defense programs.

89. Our conviction that active air defense will continue to receive very high priority in the USSR is supported by the history of the Soviet military establishment from the end of World War II until the present. This has been marked by a consistently strong emphasis on air defense. The scale of effort currently being applied to modernizing the system indicates that this attitude persists. Moreover, the general tenor of the Soviet announcements of January 1960 regarding future military policy point to a continuing high priority for air defense. They also indicate that Khrushchev contemplates heavily increased reliance on missiles to enhance Soviet capabilities for air defense as well as for strategic attack. Finally, it seems certain that the Soviet planners would estimate that the manned bomber threat will continue to be present for at least the period of this estimate, and that in the meantime a system will have to be developed to cope with ballistic missiles.

90. The deployment patterns of air defense weapons and equipment within the Bloc show that the system is designed primarily to provide defense in depth for the major population, industrial, and military centers of the USSR. Soviet planners will recognize that, while successful defense against sustained high explosive attack could be achieved by imposing a high rate of attrition on penetrating forces, defense against high-yield nuclear weapons would require achievement of a very high assurance of denying access to vital targets. Consequently, they will seek to provide air defense capabilities to meet each type of Western offensive delivery system, to protect major population and industrial centers by both active and passive means, and to protect their own strategic striking forces by active defense, by concealment, dispersal, or mobility as appropriate, and by hardening in some instances.

Probable Soviet Requirements

91. On the basis of information we believe they can acquire, largely through overt means, Soviet planners can probably estimate fairly accurately the numbers, types, and worldwide dispositions of the weapons and delivery systems the US and its allies could employ against the Bloc. They can probably anticipate, several years in advance of operational dates, the weapon systems the West is likely to add to its inventory in future years. However, the Soviets are probably uncertain as to the planned tactics and employment of Western delivery vehicles in the event of general war.

92. Soviet planners will be aware that, during the next five years, the greatest weight of attack (in megatonnage) that can be launched against the USSR will be in manned bombers, most of them subsonic medium and heavy types. They will expect no increase in the numbers of subsonic bombers, but they will anticipate a continuing improvement in techniques and tactics, especially for low altitude penetration and weapon delivery. The Soviet problem of defense against aircraft will be complicated by the variety of relatively small bombers and fighter bombers with supersonic capabilities now entering or soon to enter Western inventories.

93. Present Western capabilities in aerodynamic vehicles, comprising aircraft and subsonic cruise-type missiles, will begin to change within the next year or two, with the advent of supersonic air-to-surface missiles designed to provide bombers with standoff capabilities up to about 500 n.m. The Soviets probably foresee US possession of considerable numbers of such missiles, and must also consider the possible subsequent appearance of air-launched ballistic missiles of approximately 1,000 n.m. range.

94. From the Soviet point of view, the surface-to-surface ballistic missile threat will become progressively greater throughout the 1960–1965 time period. Missiles with great diversity

in ranges, times of flight, and other characteristics will be deployed in widely dispersed locations in the US and Eurasia. US submarine-launched ballistic missiles are scheduled to become available in 1960. The Soviets may also view Western space vehicles, including reconnaissance satellites, as potentially requiring some counteraction.

95. In considering the forms and scales of attack which might be directed at critical Bloc targets by the Western forces outlined above, Soviet planners would in most cases have to assume that a combination of weapon systems, tactics, and penetration aids would be employed. They would also assume that high-yield nuclear weapons commensurate with payload-carrying capacity would be incorporated into virtually all delivery vehicles directed against the USSR. These factors, together with uncertainty as to Western offensive tactics, will require the USSR to maintain a mixed force of air defense weapon systems through the period.

96. Finally, Soviet planners will take into account the effect of warning time on the capabilities of air defenses in various areas of the Bloc. Land-based early warning radar could now give Moscow and many other targets in the interior of the USSR more than one hour's warning of attacks made with subsonic bombers. The more limited early warning time available in Bloc border areas would reduce the effectiveness of even heavy defenses in such areas. As the speeds of Western aerodynamic vehicles increase, and as Western ballistic missiles become a greater part of the threat, the problem of warning time will become more critical.

Major Near-Term Developments

97. We believe that the current program of SA–2 deployment is intended to provide, on a high priority basis, missile defenses for those individual targets which the Soviets consider of greatest value to the USSR. Based on an analysis of the deployment pattern suggested by the evidence at hand, it appears that SA–2 defenses of various degrees of density are programmed for all Soviet cities with populations of over 300,000, as well as for a number of other locations of key importance to the Soviet economy, the military establishment, and the government control apparatus. If this general SA–2 pattern were completed along the lines presently indicated, it would require a total of some 350–400 sites (excluding the 56 SA–1 sites around Moscow), deployed at about 70–80 locations including about 60–65 urban-industrial areas. In addition to activating the necessary firing units with trained personnel, equipment, and logistic support, such a program would involve providing a total operational inventory of some 17,000 to 19,000 missiles, assuming three missiles per launcher—two on site and one in immediate reserve. This inventory would include the number required for substitution of the SA–2 missile for the SA–1 missile in the defenses around Moscow. Considering the rate at which we believe deployment has proceeded in the recent past, we estimate that a basic program of this magnitude could be completed by the fall of 1960.

98. It is possible that a somewhat greater density of SA–2 defenses is planned for certain locations and that additional targets will be so defended. Moreover, it is likely that mobile SA–2 systems will be allocated to Soviet forces in the field. A more extensive program, taking these additional factors into account, might call for a total of some 500–600 individual SA–2 sites and field force units. If this were the case and deployment proceeded at the apparent recent rate, the program could probably be completed some time in 1961. If SA–2 missiles were allotted to other countries of the Bloc, this program would have to be expanded and might extend somewhat beyond 1961. After the current program is completed, we believe that the Soviets will have acquired relatively effective missile defense for their major target areas against medium and high altitude air attack.

99. Previously, the USSR relied upon interceptors as the prime air defense weapon, except in the single instance of Moscow. We

believe that the trend is now toward a combination of fighter and missile defenses. These will probably be employed in fairly well-defined zones, in order to effect proper coordination between fighters and missiles and to provide the defense in depth which the Bloc air defense system aims to achieve. Moscow will remain heavily defended by surface-to-air missiles with coverage out to about 75 n.m. from the center of the city, with a zone beyond primarily for fighter engagement. Elsewhere, surface-to-air missiles will cover key targets, with fighters probably employed in existing gaps. In the Urals, the Ukraine, and possibly the southern Maritime region of the Soviet Far East, the number and concentration of defended locations will create area-type defenses despite the limited range of individual missile sites. Likely sea and border approaches to the USSR will be protected by barriers of advanced day and all-weather fighters, and possibly by surface-to-air missiles as well.

100. The proportion of fighters in the combined fighter-missile defense system will decline. In terms of absolute numbers, we estimate that between 1960 and 1965 the total number of Soviet fighters will be reduced significantly from the present strength of about 10,000, perhaps by as much as 50 percent. The transfer since 1957 of certain fighter units to PVO control probably indicates that the IA PVO will not decline in strength as rapidly as the fighter units of Tactical and Naval Aviation.

101. As suitable surface-to-air missiles become available in quantity, a large proportion of the medium and heavy antiaircraft guns will probably be phased out of the defenses of static targets in the USSR. There is a very limited amount of evidence that such a trend has already begun. Transfer of some of this equipment to Soviet field forces and to other Bloc countries is probable. Light AAA, especially automatic weapons, will be retained for low altitude defense until low altitude surface-to-air missile strength is well established.

Advanced Surface-to-Air Missiles [7]

102. The USSR has an urgent requirement for improved surface-to-air missile defense against aerodynamic delivery vehicles—in particular, for defense against very low altitude targets and for interception at longer ranges and higher altitudes than present Soviet surface-to-air systems. The USSR has the technical capability to produce such systems. Although there is no evidence, we estimate that they probably are now in process of development.

103. *SA–3 Low Altitude System.* A system (SA–3) specifically designed for altitudes down to about 50 feet could become available for first operational use late in 1960, although an initial capability in 1961 would be more likely. Maximum intercept range would be on the order of 10 n.m. against low altitude targets and about 25 n.m. against medium altitude targets up to at least 40,000 feet. Other characteristics are tentatively estimated as follows: maximum missile velocity, Mach 2 to 3; warhead weight, 150–250 pounds; CEP, 20–50 feet.

104. We have no evidence regarding the deployment of a low altitude system in defense of major Soviet target areas. However, if it were accorded high priority, we believe that the SA–2 defenses of static targets could be adequately supplemented with low altitude SA–3 units by the end of 1962 or in 1963. The SA–3 system could also be deployed in mobile units to augment the defenses of Soviet field forces against low-level air attack.

105. Surface-to-air systems could also be installed on surface ships of the Soviet Navy, although their use would require extensive alterations to existing ships or the construction of classes specifically designed as missile ships. Adaptations of SA–2 and SA–3 would be suitable as surface-to-air armament for destroyers and cruisers.

106. *Long Range High Altitude System.* Longer range, higher altitude surface-to-air

[7] For estimates of future Soviet air defense missile developments, see NIE 11–5–59, "Soviet Capabilities in Guided Missiles and Space Vehicles," dated 3 November 1959, (Top Secret) and the forthcoming NIE 11–5–60.

missiles would increase the effectiveness of Soviet air defense, particularly against advanced aircraft and air-to-surface missiles. However, in view of the widespread deployment and estimated growth potential of the SA–2 system, we now consider it very unlikely that the Soviets will attempt to meet this requirement with an entirely new system as previously estimated (SA–4), at least in the near term. Rather, technical improvements will probably be made in the altitude and range capabilities of the SA–2 system. Significant improvements in this system could appear in about 1961.

Antiballistic Missile System

107. We do not know what technical approach the Soviets are employing in what we believe to be a very high priority program to develop defenses against ballistic missiles. Solution of the problems of an antimissile missile would involve the development of complex and costly components and their integration into a weapon system with high capabilities for distant detection, identification, discrimination, and interception. The net result would be heavily dependent on tactics, deployment, and the effectiveness of Western countermeasures. Taking these factors into account, we can conclude only that such a system (SA–5) could become operational in the 1963–1966 period, and that it would have an undetermined capability against Western ballistic missiles.

108. The USSR is probably also exploring unconventional techniques for active defense against ballistic missiles. We cannot predict the nature or success of such studies. In any case, continuous research and development in antimissile defenses will be underway during the next five years and beyond.

Future Fighter Aircraft

109. Soviet introduction of new fighter aircraft types into the combined fighter-missile defense system will continue through at least the early 1960's. In addition, the Soviets, during the period of this estimate, will probably continue their research and development activities on supersonic fighter aircraft.

110. To alleviate their all-weather fighter deficiency, the Soviets probably will introduce during 1960 a development of FISHPOT with all-weather capabilities. We estimate that in 1962 the Soviets may introduce a new or improved all-weather interceptor with a better performance and fire control system. This estimate is based solely on estimated Soviet requirements and technical capability. Such an aircraft could probably achieve speeds up to Mach 2.5 and have a combat ceiling of nearly 70,000 feet. Its airborne intercept radar could probably have search and track ranges of 40 and 25 n.m. respectively, a considerable improvement over the Soviet's best current AI capabilities.

111. The rate of fighter production and introduction into units in the early 1960's will probably increase somewhat over that of the last year or two, but it will remain low by comparison with earlier years. Older fighters will be gradually phased out of Soviet forces and not replaced on a one-for-one basis. The primary Soviet effort in the fighter field will be to improve the armament and electronic capabilities of individual interceptors and to perfect techniques for their control and employment.

112. *Air-to-Air Missiles.* The Soviet fighter force may be generally equipped with air-to-air missiles. It would be logical for the Soviets to make air-to-air missiles the primary armament of all new fighter types appearing this year or later. In 1960, the USSR could have an improved air-to-air missile (AA–4) with a head-on attack range of 15–20 n.m. However, introduction into service of such a missile probably would depend upon the availability of a suitable nuclear warhead. In the absence of further nuclear testing, the Soviets would probably design any nuclear air-to-air missile to be compatible with a previously tested nuclear device. A more sophisticated version (AA–5) could become available in 1963.

Warning and Control [8]

113. Soviet efforts to improve the Bloc's air defense electronic capabilities will probably be directed primarily toward more widespread deployment of the high performance equipment which has already appeared and toward the more effective integration of the entire air defense system. Important objectives of this effort will be to increase the early warning time available and to reduce the time required to solve successfully all phases of the intercept problem, from detection to engagement and kill.

114. The newest Soviet early warning radar, BAR LOCK, is estimated to have a high probability of detection out to ranges of about 220 n.m., as compared with TOKEN's maximum detection range of about 190 n.m. with somewhat lower probability. BAR LOCK and other radars with similar performance will probably become the major Bloc early warning equipment in 1960–1965, although a new type may appear late in the period. BAR LOCK's detection range should provide warning of the head-on approach of subsonic medium and heavy bombers at high altitudes when they are some 24 to 28 minutes from the radar site; TOKEN's capabilities in this respect are probably at least 20 minutes. These detection ranges are sufficient so that, even when a portion of the intercept problem must be solved by manual communications and data-handling methods, enough time will be available for fighters on two-minute alert to reach altitude and engage. (This assumes straight-line courses and the colocation of radar and fighters.)

115. Against smaller delivery vehicles approaching at speeds of 1,200 knots or more, the problem will be much more difficult. BAR LOCK and comparable radars would provide warning when the target was about 11 minutes from the radar site, TOKEN about nine minutes or less. The rapid introduction of data-link communication and control systems, together with the use of computers in air defense sector headquarters, will eliminate much delay in processing information. GCI equipment with better tracking ranges and height-finding capabilities are being installed. The more advanced all-weather fighters may be equipped for completely automatic control of interception. But even for newer fighters on two-minute alert, the total time required from detection to engagement would probably be some 8–10 minutes. We therefore believe that in areas where radars cannot be sited well forward of targets and fighter bases (e.g., along Bloc borders), warning time for fighters will be marginal against the highest performance Western aerodynamic vehicles.

116. The problem of warning time for surface-to-air missiles probably will not be so stringent. In the usual case, where target acquisition has been made by the SPOON REST located in the immediate vicinity of the SAM site, adequate warning time is available. Correlation of target data could be accomplished in 1–2 minutes, a period of time which would enable the SAM site to prepare to engage the target. We do not have evidence as to the method the USSR will use to tie in its national early warning network with its expanding missile defenses. It appears possible that semiautomatic control will be employed for such use as well as the control of fighters.

117. To the degree that geography will permit, the USSR is extending its early warning capabilities by siting equipment beyond its land borders. The European Satellite area will remain a valuable forward base for Soviet early warning lines. In the Arctic, radars have been installed on islands north of the Soviet coast. In addition, passive detection systems in Soviet and East European border areas will probably be integrated into the air defense system to counter jamming and augment the early warning network. There is as yet no evidence that the Soviets plan to employ airborne early warning patrols, but this would be within their capabilities.

118. For ground communications in support of air defense operations the Soviets will continue to use and to improve high frequency radio and microwave links, and coaxial cable will also continue in limited use. The systems installed during the next five years, especially

[8] For a graphic presentation of estimated Bloc early warning capabilities 1960–1965 see Map, Annex B.

in the microwave network, will be capable of relaying signals over long distances without serious degradation and will have low vulnerability to jamming and interception. We estimate that by 1965, more than 90 percent of the short-distance operational air defense traffic will be carried on microwave links and landlines. Tropospheric scatter communications may also be employed in certain areas, such as the Arctic.

Nuclear Weapons

119. Major advances in yield-to-mass ratio and in fissionable material economy would be Soviet goals for improvement in air defense warheads, but could be achieved only with the resumption of nuclear tests. In the absence of such tests, progress in the very low yield category, such as required for air-to-air missile warheads, would be seriously hindered.

120. At present, nuclear warheads appear to offer the best promise for destruction of targets outside the atmosphere. We estimate that the Soviets would utilize such warheads in air defense systems designed to intercept ballistic missiles and satellites. Two of the thermonuclear devices tested by the USSR in 1958 might lend themselves to antimissile defense applications. However, we have no evidence of Soviet nuclear tests at very high altitudes (above 30,000 feet or in space) and believe that they lack basic effects data on high altitude and space detonations. In the absence of further nuclear testing, the lack of such data would not prevent development of a nuclear-armed antimissile system, but would handicap development of such a system.

Other Bloc Nations

121. The air defense forces of the other Bloc nations will remain inferior to those of the USSR. They will be augmented by the transfer of fighters and antiaircraft guns from Soviet stocks, continued local production of such equipment (largely from Soviet designs), and the provision of up-to-date radar and communications equipment to serve their own and Soviet needs.

122. It is unlikely that the USSR has supplied surface-to-air missiles to the forces of any other Bloc nation, or that it will do so until priority Soviet requirements are met. The SA–2 installations in East Germany are almost certainly Soviet-controlled and operated for the defense of Soviet military installations. However, as the SA–2 deployment program is completed in the USSR, the Soviets will probably make this system available in at least limited numbers for the protection of key static targets. The most likely locations for initial deployment would be the East European Satellite capitals and major Chinese urban-industrial areas. Judging by estimated trends in the USSR, limited numbers of SA–2 missiles and associated equipment could be provided to other Bloc nations beginning in 1961 or 1962.

123. There are indications that some type of air-to-air missiles may now be in the hands of East German and Chinese Communist fighter elements. In any event, considering that the Chinese Nationalists have used air-to-air missiles with telling effect, we believe that the Chinese Communists either now have or will soon receive Soviet air-to-air missiles. Other Satellite fighter forces may follow suit.

124. The USSR will probably not provide nuclear warheads for Satellite or Chinese use or custody during the period of this estimate. This judgment is based in part on our belief that the USSR's own requirement for air defense warheads is very large, and in part on the reluctance of the USSR to provide nuclear weapons of any kind to the Satellites or Chinese. It is possible that the Soviets might provide nuclear support to the Chinese in case of need (see NIE 11–4–59, paragraph 120).

Future Soviet Air Defense Capabilities

125. We believe that the Soviets will continue to improve the overall capability of their large and complex air defense establishment. Despite these improvements, the Soviets probably will still not achieve within this time period a high degree of assurance in dealing with a large-scale sophisticated attack by manned bombers armed with high-yield nuclear weapons. They would probably expect

to destroy a significant number of the attackers, but, given the increasing complexity of the air defense problem, we doubt they will be confident of the extent to which they could reduce the weight of any given attack.

126. The Soviets are undoubtedly making vigorous efforts to counter more advanced Western weapon systems, particularly ballistic missiles. But, barring an unforeseen technological breakthrough, we believe that the USSR's air defense problems, deficiencies, and uncertainties will increase toward the end of the period as ballistic missiles assume a larger proportion of the West's total nuclear delivery capability.

ANNEX A

TABLES OF AIR DEFENSE EQUIPMENT*

Characteristics, Strength, and Deployment

* NOTE: For tables on Soviet air defense missile characteristics see NIE 11-5-59: "Soviet Capabilities in Guided Missiles and Space Vehicles," (3 November 1959, Top Secret) and the forthcoming NIE 11-5-60. Tables on personnel strengths and future force strengths have not been included. These subjects are now being examined in detail, and will be dealt with in forthcoming estimates.

TABLE 1

ESTIMATED PERFORMANCE OF SOVIET INTERCEPTOR AIRCRAFT [a]

	FAGOT	FRESCO A & B [f]	FRESCO C	FRESCO D	FARMER A [b]	FLASH-LIGHT A	FITTER [i]	MIG-TYPE [j]	FISHPOT [i]	ALL-WEATHER FIGHTER [k]
Year Into Service	1950	1953	1954	1955	1955	1955	1959	1960	1960	1962
Speed [b] (kts) Combat	505	535	545	545	640	515	1,035	..	..	1,440
Maximum	585	570	570	570	735	610	1,185	1,035	1,150	1,440
Combat Ceiling [c]	51,000	53,000	54,500	54,500	61,100	49,300	60,400	60,200	62,000	68,000
Climb to 40,000 ft (min):										
Military Power	7.6	8.5	8.2	8.2	4.8	7.8	3.5	..	3.0	3.1
Maximum Power	7.6	8.5	5.1	5.1	2.6	7.8	2.2	2.5	2.2	1.7
Combat Radius/Range (nm) [d]										
Standard Mission	195/435	215/480	175/470	175/470	180/—	380/805	75/455	..	65/420	225/385
Optimum Mission	280/605	300/655	265/645	265/645	290/780	450/945	140/590	..	130/555	..
Optimum/External Fuel	490/1,025	530/1,120	505/1,100	505/1,100	655/1,475	530/1,100	480/1,245	580	440/1,160	..
Radar:										
Type	[e]	[e]	[e]	Search/ Track.	Range Only.	Search/ Track.	Range Only.	Range Only.	Search/ Track.	Search/ Track.
Range (nm)	[e]	[e]	[e]	5-6/2-3	3	12-16/6-10	3	3	12-14/8-9	40/25
Armament:										
Guns	2x23mm 1x37mm	2x23mm 1x37mm	2x23mm 1x37mm	3x23mm	2x23mm 1x37mm	2x37mm	2 revolver [j]	3 revolver [j]	2 revolver [j]	None.
Rockets [g]	and 16x55mm or 2x220mm or 2x325mm	and 16x55mm or 2x220mm or 2x325mm	and 32x55mm or 4x220mm or 4x325mm	and 32x55mm or 4x220mm or 4x325mm	and 32x55mm or 4x220mm or 4x325mm	and 95x55mm or 5x220mm or 5x325mm	or 76x55mm or 4x220mm or 4x325mm	or 76x55mm or 4x220mm or 4x325mm	and 76x55mm or 4x220mm or 4x325mm	6x220mm
Missiles [h]	.....	or 2 AAM	or 4 AAM	or 4 AAM	or 4 AAM	or 5 AAM	or 4 AAM	or 4 AAM	or 4 AAM	or 6 AAM

See footnotes on next page

Footnotes for Table 1.

[a] Unless otherwise noted, performance figures are calculated with internal fuel only.

[b] Combat speed is at 50,000 feet altitude; maximum speed is at optimum altitude.

[c] Highest altitude with internal fuel only at which an aircraft with standard armament can climb at a rate of 500 feet per minute with maximum power.

[d] Standard mission is calculated in accordance with US Mil C-5011A Spec. Optimum mission is the same except that fuel reserves are reduced to permit extended range. Calculations for an optimum mission with external fuel assume two wing tanks except in the case of the FLASHLIGHT A which carries one belly tank.

[e] These are considered to be maximum loads, with internal fuel only, and do not exclude the possibility of other combinations of rocket and missile armament. The numbers shown for the 220 mm rocket also apply to the 210 mm rocket, not included in this table.

[f] FRESCO "E" has performance characteristics similar to those of the FRESCO "A" and "B," but is equipped with airborne intercept radar of the FRESCO "D" type.

[g] Some of these aircraft are equipped with range only radar which has a range of one n.m.

[h] Two other versions have been identified. FARMER "B," which has performance characteristics similar to those of FARMER "A," has airborne intercept radar with a search range of 7-9 n.m. and a track range of 3-5 n.m. FARMER "C" is believed to have improved performance over the "A" and "B" models, and has range only radar of the FARMER "A" type. Both FARMER "B" and "C" and some FARMER "A's" have revolver type guns.

[i] Estimated performance characteristics are based primarily on analysis of prototypes which appeared in 1956, and may differ in the production models.

[j] Believed to be a MIG-type probably developed from the FACE PLATE/FISH BED series which appeared in 1956.

[k] Development of this aircraft estimated on the basis of Soviet requirements.

[l] Revolver type guns are 23-33 mm caliber.

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TABLE 2

ESTIMATED PERFORMANCE AND CHARACTERISTICS OF SOVIET EARLY WARNING AND GCI RADARS

Type	Frequency (MCS)	Early Warning Radar			Ground Control Intercept Radar		
		Max. Detection B-47 (Nose-on)	Range (nm) F-100 (Nose-on)	Max. Altitude Coverage (ft)	Tracking B-47 (Nose-on)	Range (nm) F-100 (Nose-on)	Altitude Coverage (ft)
KNIFE REST A	70–75	[a]150	[a]115	180,000			
KNIFE REST B	80–87	[a]160	[a]125	220,000	...	...	...
TOKEN	2,700–3,100	[a]190	[a]175	75,000	[a]110	[a]100	70,000
BIG MESH							
S-Band	2,700–3,100	[b]215	[b]215	130,000	[a]170	[a]155	110,000
L-Band	570	[b]215	[b]215	120,000			
BIG BAR	2,700–3,100	[b]215	[b]215	130,000	[a]170	[a]155	110,000
STRIKE OUT	2,700–3,100	[a]190	[a]175	120,000			
STRIKE OUT/ROCK CAKE	2,700–3,100/2,600–2,630	.....	.....	.....	[a]185	[a]170	120,000
CROSS OUT							
S-Band	2,700–3,100	[b]220	[b]220	220,000	...	...	...
L-Band	570 (est.)	[b]220	[b]220	220,000			
CROSS OUT/STONE CAKE	2,700–3,100/2,600–2,640	.....	.....	.....	[b]215	[b]210	220,000
BAR LOCK							
S-Band	2,700–3,100	[b]220	[b]220	220,000	...	...	...
L-Band	570 (est.)	[b]220	[b]220	220,000			
BAR LOCK/STONE CAKE	2,700–3,100/2,600–2,640	.....	.....	.....	[b]220	[b]210	220,000
POSSIBLE NEW RADAR (1965).							
L-Band	.....	400	400	300 000	400	400	300.000

[a] In determining these ranges, a 25 percent blip-scan ratio was assumed. Range at 25 percent blip-scan ratio is believed to represent probable maximum detection range. Tracking, however, would require blip-scan ratio on the order of 50 to 75 percent which would be achieved at about four-fifths to two-thirds of the stated range.

[b] These figures represent our best estimate of radar performance as limited by pulse repetition frequency (PRF). At these ranges, a 60 percent blip-scan ratio would be achieved. Ranges could be considerably greater if the Soviets have evolved techniques for detecting ambiguities in range data and determining true ranges.

TABLE 3

ESTIMATED CHARACTERISTICS OF SOVIET ANTIAIRCRAFT GUNS

Weapon	Effective Ceiling	Projectile Weight and Type	Muzzle Velocity	Rate of Fire	Remarks
12.7 mm AA DShK HMG, M1938 and M1938/46.	3,000 ft....	0.1 lb., AP.....	2,800 fps..	80 rpm per barrel....	Standard on T–54 tank and APCs. Quad mount of Czech origin.
14.5 mm AA HMG ZPU–1, ZPU–2, ZPU–4.	3,500 ft....	0.12 lb., HE....	3,300 fps..	80 rpm per barrel...	Single, dual, and quad mount.
Twin 30 mm AA Gun, M1953.	7,000 ft....	1.0 lb., HE.....	3,000 fps..	600 rpm per barrel...	Power laying. Of Czech origin.
37 mm AA Gun, M1939..	9,850 ft....	1.61 lb., HE....	2,900 fps..	160 rpm.....	...
57 mm AA Gun, S–60...	6,000 ft[a]....	2.8 lb., HE.....	3,300 fps..	60 rpm per barrel....	Twin, self-propelled version also in use, known as ZSU–57–2.
85 mm AA Gun, M1939..	27,500 ft...	20.3 lb., HE....	2,600 fps..	15–20 rpm.....	Radar fire control.
85 mm AA Gun, M1944..	33,500 ft...	20.3 lb., HE....	3,000 fps..	15–20 rpm.....	Radar fire control. Czech version has similar characteristics.
100 mm AA Gun, KS–19.	35,000 ft...	34 lb., HE[b].....	3,000 fps..	15–20 rpm.....	Power laying and radar fire control.
130 mm AA Gun, M1955[c]	39,000 ft...	74 lb., HE[b].....	3,000 fps..	15 rpm.....	Radar fire control.

[a] For on-carriage sighting. With radar fire control, effective ceiling is estimated at about 16,000 ft. ZSU–57–2 does not have off-carriage fire control.

[b] Proximity fuzes are believed to be available.

[c] Previously reported as 122 mm AA Gun, M1955.

TABLE 4

ESTIMATED ACTUAL STRENGTH AND DEPLOYMENT OF SINO-SOVIET BLOC AIR DEFENSE EQUIPMENT
(1 January 1960)

Area	Jet Fighter Aircraft in Operational Units		EW-GCI Radar Sites		Antiaircraft Guns	
	Regiments	Aircraft	Primary	Secondary	Light	Medium/ Heavy [e]
Northwestern USSR [a]	41	1,350	82	95	1,000	700
Western USSR [b]	92	2,925	109	92	4,250	2,050
West Central USSR [c]	47	1,515	111	110	1,550	2,200
Caucasus USSR [d]	42	1,330	82	90	1,250	900
East Central USSR [e]	26	855	90	103	700	850
Far East USSR [f]	48	1,540	105	152	2,250	1,250
Total in USSR	296	9,515	579	642	11,000	7,950
Soviet Forces, Eastern Europe	32	1,090	40	93	2,100	650
(Total Soviet)	(328)	(10,605)	(619)	(735)	(13,100)	(8,600)
European Satellite	67	2,175	90	188	2,450	2,800
Total Eastern Europe	99	3,265	130	281	4,550	3,450
Asiatic Communists	70	2,340	56	310	2,350	1,700
Total Bloc	465	15,120	765	1,233	17,900	13,100

[a] Includes Northern and Leningrad Military Districts.

[b] Includes Baltic, Belorussian, Carpathian, Kiev, and Odessa Military Districts.

[c] Includes Moscow, Volga, Voronezh, and Ural Military Districts.

[d] Includes North Caucasus and Transcaucasus Military Districts.

[e] Includes Siberian and Turkestan Military Districts.

[f] Includes Far East and Transbaikal Military Districts.

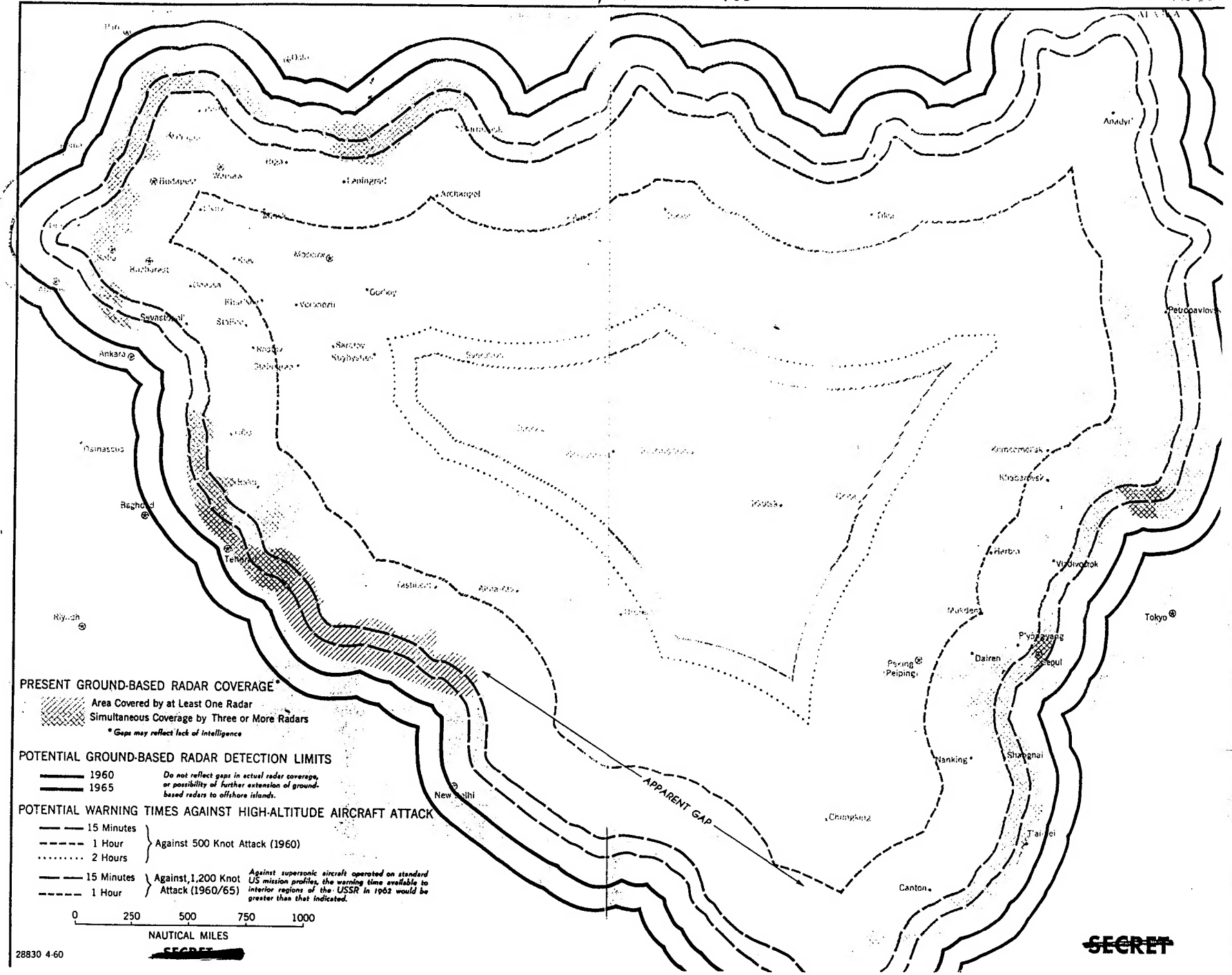
[g] Includes about 500 heavy antiaircraft guns deployed principally in West Central USSR.

TABLE 5

COMPOSITION OF BLOC FIGHTER FORCES BY AIRCRAFT TYPE (MID-1960)

	USSR	EE Satellites	Communist Asia
FAGOT	1,500	1,500	1,600
FRESCO A, B, C	5,700	620	510
FRESCO D, E	900	80	105
FARMER A, B, C	1,100	145	35
FLASHLIGHT	450	.....	.....
FITTER/FISHBED Type	400	.....	.....
TOTAL	10.050	2.345	2.250

ESTIMATED LIMITS OF BLOC EARLY WARNING CAPABILITIES, 1960 AND 1965



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